



Lower Colorado River Multi-Species Conservation Program

Draft Five-Year Monitoring and Research Priorities for the Lower Colorado River Multi-Species Conservation Program (2008-2012)

**Lower Colorado River
Multi-Species Conservation Program Office
Bureau of Reclamation
Lower Colorado Region
Boulder City, Nevada
<http://www.lcrmscp.gov>**

May 2007

INTRODUCTION

The Lower Colorado River Multi-Species Conservation Program (LCR MSCP) is a multi-stakeholder, Federal and non-Federal partnership, created to balance the use of Lower Colorado River (LCR) water resources and the conservation of native species and their habitats in compliance with the Endangered Species Act. This program is a long-term, 50-year plan to conserve at least 26 Federal and state-listed candidate and sensitive species along the LCR, from Lake Mead to the Southerly International Boundary with Mexico, through the implementation of a Habitat Conservation Plan (HCP) (LCR MSCP 2004a). The Bureau of Reclamation (Reclamation) is the entity responsible for implementing the LCR MSCP. A Steering Committee, currently consisting of 54 entities, was formed as described in the *LCR MSCP Funding and Management Agreement* (FMA) (LCR MSCP 2004b) to provide input and oversight functions in support of LCR MSCP implementation.

The HCP conservation measures were designed to meet the biological needs for 26 covered species and potentially benefit 5 evaluation species included in the LCR MSCP. The HCP provides program-level guidance for ensuring that implementation of the conservation measures is based on scientific information, methods, principles, and standards. Through utilization of adaptive management principles, new information obtained on species and their habitats can be utilized to implement biologically effective and cost-efficient conservation actions. The HCP acknowledged the need for implementing research and monitoring priorities within the first 20 years of the LCR MSCP period, and implementation costs for monitoring, research, and adaptive management reflect these priorities (HCP Table 7-1).

A *Draft Science Strategy* was developed in August 2006, which outlines the adaptive management process (LCR MSCP 2006a). The science strategy describes a two-tier planning process to ensure effective implementation of research and monitoring actions. These tiers are a 5-year planning cycle, and annual work plans. Every 5 years, a plan will be developed that describes the current knowledge of covered species and their habitats, priorities for research and monitoring to provide additional information needed for the ensuing 5-year period, and any potential challenges that may inhibit successful implementation of scientifically sound conservation measures. An annual work plan that summarizes prior year accomplishments, describes current year ongoing activities, and outlines the proposed activities for the coming fiscal year will be presented to the Steering Committee each year. These annual work plans enable adaptive management to occur in a timely manner, and ensure implementation of 5-year priorities.

A four-step process for identifying 5-year priorities is described in the *Draft Science Strategy*:

- Identifying current knowledge and data gaps.
- Initial ranking of data needs.
- Review initial data ranking and propose priorities.
- Determine final data need priorities.

The first 5-year planning cycle for LCR MSCP implementation covers fiscal years 2008 through 2012. This document (*Five-Year Monitoring and Research Priorities for the Lower Colorado River Multi-Species Conservation Program (2008-2012)*) establishes monitoring and research

priorities for each implementation element described in the HCP: Fish Augmentation, Species Research, Created Habitat Research, System Monitoring, and Post-Development Monitoring. The document provides the 5-year research and monitoring priorities for individual covered species, species guilds, and their habitats needed to successfully implement the conservation measures described in the HCP. Priorities have been established based on information outlined in the species accounts completed in 2007 (LCR MSCP 2007a).

Ongoing research and monitoring programs may continue into this 5-year planning cycle. Table 1 describes continuing research and monitoring projects proposed in the FY08 annual work tasks (LCR MSCP 2007b). New data accumulated from research and monitoring activities will be reviewed throughout the 5-year planning cycle. Results from the research and monitoring activities outlined in this document will be evaluated during 2012 and new priorities will then be established for the next 5-year cycle (2013-2017). Some research and monitoring priorities that begin during this initial 5-year planning cycle are not anticipated to be completed until after 2012. The evaluation scheduled for 2012 will account for these long-term projects.

Fish Augmentation

The LCR MSCP Fish Augmentation Program will rear and stock 1.2 million native fish into the Lower Colorado River (LCR MSCP 2006b). The fish program has two focus areas for monitoring and research: fish propagation and fish distribution. Monitoring of these areas is accomplished through production and distribution records kept at each facility, which are summarized in annual reports and progress reports from each facility. For example, Willow Beach NFH records all of the larval razorback sucker (RASU) received from the Lake Mohave Native Fish Work Group partners during the spring, tracks growth and survival of each year-class of fish kept on station, and tracks and records all fish leaving the station, whether for transfer to another facility or for stocking into receiving waters. This monitoring is sufficient to assess effectiveness of the augmentation program.

When considering research activities and priorities, it is important to note that RASU and bonytail (BONY) are rare fishes, and have only been in captivity for a few decades. Propagation and culturing techniques used for other fishes, such as rainbow trout and channel catfish, do not always work for these two native Colorado River species. During FY06 and FY07, the procedures used by various facilities to rear RASU and BONY were reviewed. A workshop is planned for summer 2007 to present the findings of these reviews, and to develop a prioritized list of research questions for culturing each species. From this priority list, study plans will be developed, and research will be initiated in 2008. Research actions will continue through 2012 or until the priority list is completed.

Research will also be initiated to examine fish distribution techniques. Once the fish are reared, they must be marked and then stocked out. Research questions pertaining to the handling, marking, and distribution of these fishes are expected to be generated during the summer 2007 workshop. Investigations to answer these questions will begin in 2008.

Species Research

General and species-specific conservation measures are described in the HCP. The LCR MSCP is a habitat-based program that was designed, in part, to create and maintain habitat for covered species. Habitat creation acreage is expected to provide habitat requirements for multiple species at numerous sites along the LCR. To effectively and cost efficiently create and manage habitats, habitat requirements for each species must be determined. Once habitat requirements have been determined, habitat creation projects can be designed to benefit the maximum number of covered species that are likely to use these sites.

Other conservation measures have been designed to identify and alleviate potential limiting factors for covered species populations. Specific research projects may be developed to provide insight on limiting factors. Information obtained from these studies will be used to help manage covered species populations and habitats.

In 2006-07, species accounts were developed for LCR MSCP covered and evaluation species using information obtained from existing literature (LCR MSCP 2007a). The amount of existing data varied between species. Some species, such as the southwestern willow flycatcher, have had extensive monitoring and research programs conducted along the LCR and elsewhere in its range. Other species, like the yellow-billed cuckoo, have been studied outside of the LCR MSCP area but little is known about local populations. Some species have limited information available for anywhere within their range. Research priorities have been determined by evaluating species or guilds that utilize each habitat described in the HCP.

Fish species

The LCR MSCP will implement conservation measures for four native Colorado River fishes: humpback chub (HUCH), flannelmouth sucker (FLSU), RASU, and BONY. The species research actions for HUCH are limited to financial support of research needs within the Glen Canyon Adaptive Management Program, and no specific species research activities are planned. Conservation measures for FLSU call for supporting monitoring and research of FLSU populations in Reach 3 for a 5-year period. This work is currently underway and will be completed in 2010. An assessment of FLSU management needs, and recommended management strategies, will be developed based on the results of the work. Any additional species research needs for FLSU beyond 2010 are expected to be identified in the assessment report.

The LCR MSCP will rear and stock some 660,000 RASU and 620,000 BONY over the life of the program. Roughly 10% of these fish are to be released over a 5-year period to allow for extensive research and monitoring. These releases are presently targeted to begin in 2011 and run through 2016. The associated research and monitoring program will also commence in 2011; however, the studies may continue through 2019, if necessary. During the summer 2007, Reclamation will develop a science advisory panel consisting of fishery scientists with knowledge of RASU and BONY life history and ecology. The panel will convene quarterly during 2008 and 2009 to develop and prioritize a multi-year research and monitoring program to coincide with fish releases. During 2010, Reclamation will organize, coordinate, and finalize study plans and scopes

of work necessary to begin the research program in 2011 along with accelerated native fish stockings.

Marsh birds

Three secretive marsh birds have been listed as covered species under the LCR MSCP: Yuma clapper rail, least bittern, and California black rail. The Yuma clapper rail nests in dense, emergent vegetation from shallow water areas near shore to deep water (>1 m depth) in interior marsh habitat (Eddleman 1989; Conway *et al.* 1993). Foraging habitat is characterized by low emergent stem densities, moderate water depths, and high percentage of open water (Eddleman 1989; Conway *et al.* 1993). Yuma clapper rails appear to be year-round residents, moving locally to interior marsh areas during the non-breeding season (Eddleman 1989; Conway 1990; Conway *et al.* 1993). Ideal habitat is a mosaic of different age and densities of emergent plants, interspersed with open water (Eddleman and Conway 1998). Home range varies from an estimated 6.7 hectares during breeding season to 24 hectares during the winter (Conway 1990). The least bittern nests in dense, tall emergent vegetation, interspersed with clumps of woody vegetation and open water (Gibbs *et al.* 1992). Nests have been found over water depths from 8cm to 96 cm (Weller 1961; Gibbs *et al.* 1992). Patch size is unknown along the LCR. In Iowa, ideal habitat is described as 50% dense, emergent vegetation and 50% open water (Weller and Spatcher 1965 in Gibbs *et al.* 1992). It is unknown if similar conditions are required along the LCR. Some least bitterns may be year-round residents or individuals from other breeding populations may winter along the LCR. California black rail habitat is characteristically dense, emergent vegetation with high canopy closure, near stand edges close to upland habitats (Flores and Eddleman 1995). Shallow, stable water depth (<3 cm) appears to be an important habitat requisite (Flores and Eddleman 1995; Tecklin 1999 in Conway *et al.* 2002).

The HCP requires the creation of 512 acres of marsh habitat. All 512 acres must provide habitat characteristics for Yuma clapper rail and least bittern habitat, while 130 acres must also provide habitat requirements for California black rail habitat within reaches 5 and 6 near existing occupied black rail habitat. Because created marsh acreage must provide habitat for all three secretive marsh birds, the ideal mosaic, incorporating habitat requirements for each species, must be developed. Many habitat requirements for the Yuma clapper rail, least bittern, and California black rail have been determined, although additional data are needed to effectively design, create, and manage these marsh habitats as a mosaic. Five-year species research priorities for the marsh birds include:

- Quantify the effects of water fluctuation on breeding Yuma clapper rails. Areas created to provide habitat for California black rails will be managed for stable water depths; however, areas created for clapper rails and least bitterns can have fluctuating water depths. Evaluating the effects of water fluctuation on known clapper rail populations may help determine possible management guidelines for habitat maintenance.
- Further define habitat requirements for least bittern, especially minimum patch size and percent vegetation/open water considered ideal for this species. Conservation measures list minimum patch size for Yuma clapper rail and California black rail (5 acres); however, no minimum patch size has been determined for least bittern. Patch size estimates have

ranged from 0.4 hectares to greater than 5 hectares elsewhere in the range (Brown and Dinsmore 1986; Gibbs and Melvin 1990 in Gibbs *et al.* 1992).

- Determine population dynamics, such as migration, seasonal movements, seasonal habitat use, and dispersal distances, to help determine potential use of created habitats. These data may help with site selection and habitat maintenance activities.
- Design a habitat mosaic to provide the habitat requirements needed by all three marsh birds within one habitat block.
- Evaluate the effects of selenium accumulation in backwaters and marsh habitats.

Secretive marsh birds, by nature, are difficult to study. Population numbers, especially California black rail populations, may limit the opportunity to complete some of these research priorities within the LCR MSCP area. Research conducted in other areas may not provide the necessary information for LCR MSCP populations. Existing population abundance and distribution must be determined to effectively conduct research on these species.

Riparian birds

Nine avian covered species utilize riparian habitat for breeding, foraging, and migration. Some covered avian species are riparian obligates while others will utilize upland habitats. All nine species will utilize cottonwood-willow stands for breeding along the LCR, although many will also use honey mesquite for breeding, foraging, migration, or wintering habitat. Several species, such as summer tanager, require habitat characteristics most readily found in mature cottonwood-willow stands, while others are more closely associated with early seral stages of cottonwood-willow stands.

The HCP requires the creation of 5,940 acres of cottonwood-willow habitat and 1,320 acres of honey mesquite habitat. Each riparian bird species has habitat creation acreage requirements listed by vegetation type and structure. By evaluating created acreage requirements and covered species habitat requirements, it is apparent that riparian habitat creation projects must be designed to provide habitat for multiple covered species at each site. Existing information was accumulated for each species, and birds with similar habitat requirements will be managed as guilds. Specific habitat requirements for each species, including potential limiting factors, will be provided in appropriate habitat creation sites.

Early Seral Stage Cottonwood-Willow Habitat

Although southwestern willow flycatchers will utilize early seral to mature willow stands, they are most closely associated with dense riparian habitat above or near saturated soils or standing water (Sogge and Marshall 2000; USFWS 2002). High stem density, canopy closure, and foliage density appear to be important habitat characteristics (Sedgwick and Knopf 1992; Sogge and Marshall 2000; McKernan and Braden 2002; Allison *et al.* 2003; Stoleson and Finch 2003; Paradzick 2005; Koronkiewicz *et al.* 2006). Nests may be located in areas with fewer temperature extremes, higher relative humidity, and cooler diurnal temperatures than non-nest sites (Koronkiewicz *et al.* 2006). Territory size can range from 0.1 to 2.3 hectares (McCabe 1991). Adults show high site fidelity between years. Southwestern willow flycatchers will forage in adjacent habitats, including mesquite. The HCP requires the creation of 4,050 acres of cottonwood-willow I-IV for

southwestern willow flycatchers, with at least 2,700 acres managed for both southwestern willow flycatchers and yellow-billed cuckoos. Minimum patch size must be at least 10 acres and surface water or saturated soils must be within 200 feet of nesting habitat. Habitat mosaics should include multiple structural classes, seral stages, and age cohorts to provide habitat for southwestern willow flycatchers and other associated covered species.

Yellow warbler habitat use mimics the southwestern willow flycatcher. Dense riparian areas, either as early successional habitat or dense understory habitat within more mature cottonwood-willow stands, are ideal breeding habitats. Yellow warblers may also utilize honey mesquite for breeding, although mesquites may provide less quality breeding habitat than cottonwood-willow (Wise-Gervais 2005). Less information is available on micro-habitat requirements for yellow warblers than for southwestern willow flycatchers. The HCP requires the creation of 4,050 acres of cottonwood-willow I-IV for yellow warblers. Habitats created for southwestern willow flycatchers and yellow-billed cuckoos are expected to provide the necessary habitat characteristics for yellow warblers.

Arizona Bell's vireos breed in streamside willow and mesquite stands that have a well-developed shrub layer, dense understory, and moderately tall overstory. High-quality habitat consists of early successional willows mixed with mesquite (Rosenburg *et al.* 1991; Serena 1986). Territories are often clumped within the habitat. The HCP calls for the creation of 2,983 acres of cottonwood-willow III-IV and honey mesquite III for Arizona Bell's vireo habitat. Early successional riparian habitat developed for southwestern willow flycatcher should provide the necessary habitat requirements for Bell's Vireo.

Vermillion flycatchers breed in open cottonwood-willow and mesquite stands, usually associated with accessible water. In central Arizona and northern Mexico, vermilion flycatchers were not found in areas where cottonwoods formed a dense canopy and mesquites created a dense understory (Carothers 1974). Nest heights range from 1 m to 18 m. Vermillion flycatchers are resident birds along the LCR, often observed within open mesquite stands during the winter. Detailed habitat requirements have not been described along the LCR. The HCP requires the creation of 5,208 acres of cottonwood-willow I-IV and honey mesquite III for vermilion flycatchers. Habitat created for southwestern willow flycatcher and yellow-billed cuckoo is expected to provide the necessary habitat requirements for the vermilion flycatcher, although the vermilion flycatcher's preference for open stands will ensure that a mosaic of different seral stages, densities, and age cohorts will need to be developed and managed.

Late Seral Stage Cottonwood-Willow Habitat

Yellow-billed cuckoos breed primarily in mature cottonwood-willow stands along the lower Colorado River, although they can occasionally be found in isolated cottonwoods or willows mixed with tall mesquites or dense saltcedar stands (Rosenburg *et al.* 1991; Halterman 2001). Yellow-billed cuckoos nest primarily in willows and forage primarily in cottonwoods, mesquites, and saltcedar. High canopy closure, high foliage volume, intermediate basal area, and intermediate tree height provide ideal habitat along the Kern River (Laymon *et al.* 1997). Standing water may be an important breeding habitat characteristic. Patch size and habitat width appear to be limiting factors, with optimal stands greater than 80 hectares and wider than 600 meters (Laymon and

Halterman 1989). Yellow-billed cuckoo population abundance fluctuates between years, possibly due to weak site fidelity and nomadic behavior caused by prey abundance. The HCP requires the creation of 4,050 acres of cottonwood-willow I-III for yellow-billed cuckoo, including at least 2,700 acres managed for yellow-billed cuckoo and southwestern willow flycatcher.

Summer tanagers require structurally well developed cottonwood-willow stands, although they will use mesquite and tamarisk at high elevations. Patch size (>9 hectares), tree height (>9 meters), and canopy closure may be important habitat characteristics for summer tanager breeding habitat (Rosenburg *et al.* 1991; Corman 2005). Brown-headed cowbird parasitism may have an affect on nest success, although existing data indicates that parasitism rates are low along the Kern River (Gallion in Robinson 1996). The larger bronzed cowbird has been recorded parasitizing summer tanager nests in Mexico (Unitt 2006). Conservation measure SUTA1 requires the creation of at least 602 acres of cottonwood-willow I-II for summer tanager. Habitat created for yellow-billed cuckoo and southwestern willow flycatcher will provide the habitat characteristics required by summer tanagers.

Three covered avian species nest in cavities found in mature saguaro cactus, mesquite, or cottonwood-willow stands. Elf owls are migratory, arriving along the LCR in March and leaving in September. Elf owls are secondary cavity nesters, relying on cavities excavated by Gila woodpeckers, gilded flickers, and ladder-backed woodpeckers along the LCR (Halterman *et al.* 1987). Home range size varies from 0.2 to 0.4 hectares, with up to 20% overlap between individuals (Ligon 1968). Breeding densities vary between habitat types, with higher densities recorded in mature riparian woodlands. Distribution and abundance is unknown along the LCR. Gila woodpeckers and gilded flickers are resident throughout the year along the LCR. Both species breed from February into July, although most breeding occurs early in the season. Gila woodpecker territory size ranges from 4.4 to 10.0 hectares (Hensley 1954). Competition from other cavity nesters, including European starlings, may be a threat to all three species. The HCP requires the creation of 4,050 acres of cottonwood-willow I-III for gilded flickers, 1702 acres of cottonwood-willow I-IV within reaches 3-6 for Gila woodpeckers, and 1,784 acres of cottonwood-willow I-II and honey mesquite III for elf owls. Gila woodpecker acreage must have a minimum patch size of 50 acres.

Five-Year Research Priorities

Habitat creation projects must be managed for multiple species or guilds by providing a mosaic of vegetation community types and structures that fulfill habitat requirements for each specific species. Habitat requirements, threats, and limiting factors are known for several species; however, for other species these have not been determined, especially along the LCR. These data must be acquired in order to effectively and efficiently create, manage, and maintain riparian habitat for covered avian species. Five-year research priorities have been determined for avian species that utilize riparian habitats, including:

- Determine water needs for riparian birds within created habitats. Southwestern willow flycatchers require standing water or moist soils during the breeding season (Sogge and Marshall 2000; USFWS 2002); however, it is unknown whether water is required throughout the entire habitat, what percent of the habitat must be wet to provide adequate

habitat requirements for breeding, how long into the breeding season water is required, and when habitat needs to provide these moist soil characteristics to attract covered species. Some species, such as yellow-billed cuckoo, may benefit from moist soils; however, data are not currently known.

- Study the effects of habitat fragmentation on southwestern willow flycatcher meta-population biology. These data are important in determining potential habitat creation sites through the site selection process.
- Determine habitat requirements and limiting factors for covered species where existing information is limited. Use these data to develop models to determine ideal habitat characteristics and habitat mosaics, at the site and landscape levels. Specific habitat requirement data that are needed include:
 - Determine micro-habitat requirements for breeding covered species, including threshold ranges.
 - Determine year-round habitat requirements for resident species, including vermilion flycatcher, yellow warbler, gilded flicker, and Gila woodpecker.
 - Determine the effects of predation and parasitism for susceptible species, including the southwestern willow flycatcher, yellow warbler, and Bell's vireo, and develop potential management actions.
 - Determine causes for population fluctuations between years for yellow-billed cuckoo, particularly the relationship between prey abundance and population size.
 - Determine relationship between water availability and insect diversity/abundance for covered avian species that rely on insects for prey.
 - Determine required breeding habitat conditions for yellow-billed cuckoo and Bell's vireo along the LCR.
 - Determine necessary breeding habitat requirements for vermilion flycatcher, including optimal tree density, shrub density, and herbaceous plant effects.
 - Determine necessary breeding habitat requirements for summer tanager, including minimum patch size and canopy closure.
- Conduct demographic studies, such as determining reproductive success, when these data are necessary for developing management actions at created habitat sites.

Specific habitat requirements for some covered species may be difficult to determine along the LCR due to limited population distribution and abundance. Assumptions may be made during initial habitat creation projects that will have to be tested through specific monitoring and research projects. Some specific research questions are dependent on certain habitat conditions that require time to reproduce, such as determining the effects of competition between European starlings and native cavity nesters. These studies may be conducted off site, if appropriate, or have been assigned a lower priority until habitat maturation can occur.

Bats

Two bat species are covered species under the LCR MSCP, the western red bat and the western yellow bat. Little is known about the life history requirements of either species, especially along the LCR. Both species will use riparian habitat, especially cottonwoods, for roosting and foraging habitat. Roosting and foraging habitat may be selected for patch size and prey abundance. Habitat use and migration may occur seasonally. Conservation measures listed in the HCP are similar for

both species. Within reaches 3-5, 765 acres of cottonwood-willow I-II and mesquite III will be created for red and yellow bats. To accomplish these conservation measures, 5-year research priorities include:

- Determine roosting habitat requirements, especially habitat level vegetation requirements such as patch size, canopy closure, species requirements, and mosaic.
- Determine local or seasonal migration to determine if local populations migrate within the LCR or elsewhere, especially during the winter.
- Determine prey abundance by habitat type to determine foraging habitat requirements.

Red and yellow bats are rare along the LCR. Some individuals have been detected along the mainstem and tributaries, such as the Bill Williams River and the Muddy River (Williams 2001; Brown 2006). These bats are not colonial so population estimates are difficult to obtain. Surrogate species, such as the hoary bat, may be used to determine habitat requirements.

California leaf-nosed bat and pale Townsend's big-eared bat are evaluation species under the LCR MSCP. Research priorities have not been established for these species.

Small mammals

The Colorado River cotton rat and Yuma hispid cotton rat are covered species under the LCR MSCP. The Colorado River cotton rat was believed to be primarily a marsh species; however, more recent studies have determined that dense grass also provides quality habitat (Andersen and Nelson 1998; Reclamation unpublished data). This species has been found in cattail/bulrush marsh, common reed, moderate to dense grass, and drier grasslands. It may be expanding into agricultural areas. The Yuma hispid cotton rat appears to be associated with dense grass within riparian habitats. Grass height and density may be important habitat requirements for this species (Cameron and Spencer 1981). The HCP requires the creation of 125 acres of marsh habitat within reaches 3 and 4 for the Colorado River cotton rat and 76 acres of cottonwood-willow within reaches 6 and 7 for the Yuma hispid cotton rat. Additional habitat may be provided for both species, especially the Colorado River cotton rat, by managing cottonwood-willow habitat for dense herbaceous cover. Five-year research priorities for small mammals include:

- Determine habitat requirements for Colorado River cotton rat in both marsh and cottonwood-willow habitats, including limiting factors influencing habitat use or selection. Additional benefits for this species may be obtained by managing some cottonwood-willow habitat creation sites for dense herbaceous and grass cover.
- Determine habitat requirements for Yuma hispid cotton rat, including limiting factors influencing habitat use or selection.
- Determine differences in use and population densities between habitat creation sites and other habitats, including agricultural lands.
- Evaluate the genetic differences between Yuma hispid cotton rat and other hispid cotton rats found in southeastern Arizona. The Yuma hispid cotton rat may be a highly differentiated subspecies with unique life history and habitat characteristics. Existing information from the southeastern Arizona subspecies, when combined with data acquired along the LCR, will provide for habitat creation and maintenance.

Little information exists on these two species along the LCR. Basic life history information, such as distribution and habitat preferences, are not entirely understood. Because these two species can not be readily distinguished from one another in the field, genetic samples need to be acquired through presence/absence surveys.

The desert pocket mouse is listed as an evaluation species under the LCR MSCP. Conservation measure requirements and existing life history studies conducted in Nevada preclude the need for priority research for this species.

Insects

The MacNeill's sootywing skipper is a covered species under the LCR MSCP. Dense quailbush is required for egg and larval stages while adult skippers require nectar-producing plants for feeding. High leaf water content may be an important habitat characteristic. The HCP requires the creation of 222 acres of skipper habitat by creating a mosaic of honey mesquite III and quailbush. Five-year research priorities include:

- Determine habitat requirements, including micro-habitat characteristics such as soil moisture, soil salinity, soil nitrogen, and plant water content.
- Determine plant community structure to design habitat mosaic including quailbush, nectar producing plants, and mesquite.

Reptiles and Amphibians

The desert tortoise, flat-tailed horned lizard, and relict leopard frog are covered species under the LCR MSCP; however, conservation measure requirements specifically target activities that utilize information from the Desert Tortoise Conservation Team, the Flat-tailed Horned Lizard Interagency Coordinating Committee, and the Relict Leopard Frog Conservation Team, respectively. Species research priorities have not been established for these species under the LCR MSCP. The Colorado River toad and the lowland leopard frog are listed as evaluation species. The Colorado River toad is a semi-aquatic species that breeds in permanent and seasonal pools or irrigation ditches in open desert, mesquite, and riparian woodland habitats (Stebbins 1985; Natureserve 2006; Brennen and Holycross 2006). The lowland leopard frog inhabits ponds and streams along water systems. Aquatic and terrestrial habitat heterogeneity appears to be an important habitat characteristic as different life cycles may require different habitat characteristics (Arizona Game and Fish Department 2001). Although created habitat goals do not require Colorado River toad or lowland leopard frog acreage, conservation measures do require life history studies on both of these evaluation species. Five-year priorities include:

- Determine habitat requirements for Colorado River toad and lowland leopard frog.
- Conduct life history studies, including population biology, determining limiting factors and potential factors for population declines for Colorado River toad and lowland leopard frog.
- Conduct studies on the potential for captive breeding and translocation within the LCR.

Plants

Sticky buckwheat and threecorner milkvetch are endemic plant species in Clark County, Nevada, and northern Mohave County, Arizona. Both species are covered species under the LCR MSCP. Conservation measures are limited to providing funding to the Clark County Multi-Species Habitat Conservation Plan Rare Plant Workgroup. Research priorities will not be set under the LCR MSCP.

Created Habitats Research

Habitat creation goals for the LCR MSCP include the establishment of 5,940 acres of cottonwood-willow, 1320 acres of honey mesquite, 512 acres of marsh, and 360 acres of backwaters. To the extent practicable, cottonwood-willow, honey mesquite, marsh, and backwaters will be restored in proximity to one other to create integrated mosaics of habitat that approximate the relationships among aquatic and terrestrial communities historically found along the LCR floodplain. During the first 5 years of the program, science and research is expected to focus on establishing land cover types. As more information is gathered through species research and species monitoring, the focus is expected to shift to the management and maintenance of created habitat.

During the first phase of the LCR MSCP, it is expected that little research on habitat creation techniques, in the classic sense, will be required to meet the goals for initially establishing LCR MSCP habitat. The techniques to efficiently and cost effectively create the needed habitat types are likely already in existence, and generally require implementing “best management practices” for construction. The primary short-term requirements for habitat creation research goals are to examine and experiment with existing techniques and their application to habitat creation goals. For example, mass transplanting is widely used for the establishment of crops such as broccoli. The mass transplanting demonstration (LCR MSCP 2007b, Work Task E7) attempts to establish large quantities of native plants using standard commercial practices. Native cottonwood and willow were collected, propagated, and mass transplanted. Survival after 2 years is greater than 95%. A seed feasibility study (LCR MSCP 2007b, Work Task E8) is documenting the collection, storage, and germination of numerous native plants. The 3-year study increases in scale from a greenhouse to a 20-acre experimental plot.

Wildlife Habitat

Research strategies for conservation areas being developed primarily as wildlife habitat (cottonwood-willow, honey mesquite, or marsh habitats) target improving vegetation growth and survival, test alternate propagation and habitat establishment techniques, determine habitat creation potential at identified sites based on current ecological functions, and evaluate technologies to assist in meeting specific habitat requirements. Short-term research projects to facilitate land cover establishment are expected to include:

- Establishing methods for collection and storage of plant propagates from native plants.
- Identifying and evaluating techniques for propagating key plant species.
- Controlling invasive and exotic plant species.
- Minimizing water usage.

Fish Habitat

Habitat creation for native fish is limited to backwater development. Implementation strategies range from making minor modifications to existing backwaters to major modifications such as the complete excavation of undeveloped land. Created habitat research for fish will focus on how to develop the physical, chemical, and biological characteristics of these backwater habitats to provide proper ecological function. Post-development monitoring will evaluate both the maturation of the sites as they develop into covered species habitat and the use of the habitat by target species.

The focus area for the first 5-year planning cycle will be the recently developed Imperial Ponds on Imperial National Wildlife Refuge. These ponds were designed with various “fish friendly” features such as rip-rap shoreline, gravel spawning-beds, increased depth, and vegetated hummocks, thought to contribute to the success of the ponds in supporting life-cycle completion by RASU and BONY. Extensive monitoring and research will be conducted to assess the relative effectiveness of these design features. However, the research will not be solely to assess backwater habitat development. The conservation measure for backwater habitat states that while the ultimate purpose of the habitat is to serve as refuges for these species, these backwaters can be used for fish production and species research during the life of the program. As there are six individual ponds on site, it is presently anticipated that at any given time during the first 5-year period, one or more ponds will be involved in fish production, one or more will be involved in species research, and one or more will be involved in created habitat research.

System Monitoring

System monitoring will be conducted to collect and analyze data on existing covered species populations and their habitats to determine status, distribution, trend, density, migration, productivity, and other important ecological parameters. Data obtained during system monitoring will provide information for habitat creation design and evaluation. System monitoring projects may utilize single species monitoring protocols, multi-species protocols, or habitat-based protocols. Initial 5-year priorities will determine status and distribution of covered and evaluation species, where appropriate to meet conservation measures detailed in the HCP.

Fish species

System monitoring for fish species will be conducted to maintain an awareness of existing populations and their habitats, and to have these data available for use as long-term assessment tools in the adaptive management program. Only three of the four covered native fish species (RASU, BONY, and FLSU) will be monitored by the LCR MSCP at this time. The system monitoring actions for RASU and BONY gather information on the status of these species by project reach. A status report will be developed annually, depicting the end-of-year status for distribution and abundance of both species. FLSU occur in Reach 3, primarily in the first 10 miles below Davis Dam. For the 2008-2010 project years, monitoring data for FLSU will be gleaned from ongoing research actions that began in 2006 and are scheduled to end in 2010. The LCR MSCP is required to review the results of this research and to develop fishery management recommendations for FLSU in this reach of the Lower Colorado River. Monitoring

recommendations for years beyond 2010 will be included in this report. The fourth species, HUCH, is essentially extirpated from the mainstem Colorado River below Grand Canyon.

With FY06 having been the first full year of LCR MSCP implementation, it is as yet unnecessary to change any part of the program. The current needs of the AMP are in the form of data collection and organization so that, when needed, the information can be readily accessed for use in the decision-making process. Data Management (G1) will fund the database management for the AMP. For native fishes, all stocking and tagging data developed by the LCR MSCP are provided to and maintained by Arizona State University (ASU) in an electronic database. Another aspect of the AMP that is needed early on is a toolbox of evaluation techniques that can gauge the effectiveness of conservation measures as they are completed. Adaptive Management Research Projects (G3) will allow for the development of these tools. Funds allocated from G3 are being used to investigate non-intrusive survey techniques to assess relative abundance of RASU.

Marsh birds

Yuma clapper rail surveys have been conducted along the lower Colorado River since the 1970s by an inter-agency group that includes federal, state, and tribal agencies. In anticipation of LCR MSCP implementation, a multi-species survey protocol was developed and tested. Implementation of the multi-species protocol began in 2006. The multi-species protocol includes Yuma clapper rail, least bittern, and California black rail and has been designed to include other species when appropriate. Five-year system monitoring priorities include:

- Continuing the inter-agency marsh bird surveys, using the current multi-species protocol, at survey points done historically.
- Determine if new sites should be included in the system monitoring effort.
- Determine black rail distribution in reaches 5-6.
- Determine if the May survey period should be extended to better detect least bittern.
- Convert existing and historical data into a digital database.
- Provide training to new surveyors.

Riparian birds

System monitoring for riparian birds has been conducted using single species protocols and multi-species protocols, depending on purpose and need. Southwestern willow flycatcher presence/absence surveys have been conducted on an annual basis since 1996, utilizing a 10-visit protocol adapted from the U.S. Fish and Wildlife Service protocol approved by the San Bernardino County Museum (McKernan and Braden 2001). In 2008, a new modified survey protocol will be conducted after input from species experts. In 2006, system monitoring for yellow-billed cuckoo was initiated using a presence/absence protocol developed jointly by USGS and Southern Sierra Research Station (Johnson *et al.* 2005). Species experts have provided input on the yellow-billed cuckoo protocol so that a standardized protocol will be in place by 2008.

Southwestern willow flycatcher and yellow-billed cuckoo surveys will help determine status and trend for these important umbrella species. System monitoring for many of the other covered avian species will be conducted using a multi-species protocol based on the point-count

methodology used by the Great Basin Bird Observatory (GBBO 2003). Population status, distribution, and trend, will be monitored for gilded flicker, Gila woodpecker, vermilion flycatcher, Arizona Bell's Vireo, yellow warbler, and summer tanager using this system monitoring protocol. Elf owl will not be adequately monitored during this riparian obligate survey as they are nocturnal. A separate survey methodology needs to be established for elf owl along the LCR.

Five-year system monitoring priorities are based on current knowledge of status, distribution, trend, and demography for each covered species. These 5-year priorities include:

- Monitor 372 acres of southwestern willow flycatcher habitat between Parker and Imperial dams to meet commitments in the SIA Biological Opinion. Determine effects of change in point of diversion of up to 400,000 acre-feet.
- Determine the need for annual surveys at all sites for southwestern willow flycatcher and yellow-billed cuckoo.
- Develop monitoring protocol for elf owls and determine population status and distribution within the LCR MSCP area.
- Determine population status and distribution for Gila woodpecker, gilded flicker, vermilion flycatcher, Arizona Bell's vireo, yellow warbler, and summer tanager within LCR MSCP area.
- Determine winter habitat use for vermilion flycatcher.
- Determine seasonal habitat use by yellow warbler.
- Develop habitat suitability index model for riparian obligate birds to quantify potential habitat.

System monitoring for riparian birds will continue using existing or newly developed protocols. These protocols will be evaluated for their effectiveness in providing necessary data for habitat creation and maintenance through the adaptive management process. New information will be utilized, when available.

Bats

System monitoring for all bats species found along the LCR has been conducted using an established protocol (Brown 2006). Distribution and relative abundance will be measured throughout the year on a seasonal basis. Five-year system monitoring priorities include:

- Determine distribution and abundance of red and yellow bats along the LCR.
- Record all bat species during acoustical surveys so that possible surrogate species may be monitored for distribution and abundance.
- Determine distance from urban areas and fan palm trees for any yellow bats detected.

Small mammals

Presence/absence surveys have been conducted on riparian restoration demonstration sites and at habitat creation sites along the LCR. Current distribution and range for the Colorado River cotton rat and Yuma hispid cotton rat are assumed from existing literature. It is unknown if these two

species distribution overlap. Because these species can not be adequately determined in the field, genetic material will need to be taken from captured individuals to determine range restrictions. Five-year system monitoring priorities include:

- Determine distribution and range for Colorado River cotton rat and Yuma hispid cotton rat.
- Determine if species range overlaps between these two species.
- Develop habitat suitability index model to quantify potential habitat.

The southerly distribution limits for the desert pocket mouse are assumed to be near Laughlin, Nevada. Pocket mice caught near Needles will be sampled to test this assumption.

Insects

MacNeill's sootywing skipper utilize dense quailbush and associated nectar producing plant species as habitat. Quailbush has been mapped using digital imagery obtained in 2004. Potential skipper habitat will be visited to determine species distribution within the LCR MSCP area. Habitat creation sites should be located near existing skipper habitat.

Reptiles and Amphibians

Two evaluation species have system monitoring priorities under the LCR MSCP, the Colorado River toad and the lowland leopard frog. Conservation measures require the protection of occupied, unprotected habitat within the funding constraints of the LCR MSCP. To accomplish these conservation measures, the following 5-year priorities have been determined:

- Determine the current distribution of Colorado River toad.
- Determine the current distribution of lowland leopard frog.
- Identify occupied Colorado River toad habitat for possible protection.
- Identify occupied lowland leopard frog habitat for possible protection.

Other covered reptile and amphibian species do not require system monitoring efforts to accomplish listed conservation measures. Existing conservation efforts will adequately monitor these species at the landscape level.

Plants

Sticky buckwheat and threecorner milkvetch are endemic plant species in Clark County, Nevada, and northern Mohave County, Arizona. Both species are covered species under the LCR MSCP. Conservation measures are limited to providing funding to the Clark County Multi-Species Habitat Conservation Plan Rare Plant Workgroup. System monitoring priorities will not be set under the LCR MSCP.

Post-Development Monitoring

Five-year priorities for monitoring habitat creation sites are similar for covered species that have conservation measures describing habitat creation goals. Prior to initiation of habitat creation projects, pre-development surveys will be conducted. After each habitat creation project or phase has been completed, post-development monitoring will occur for targeted covered species and their habitats. Species monitoring protocols will be similar to those used for system monitoring, whenever appropriate. Habitat models will be created and tested to more efficiently monitor pre- and post-development. Best management practices will be developed for managing created habitats to ensure these habitats provide the required site characteristics for targeted covered species. Five-year post development monitoring priorities include:

- Evaluate protocols for monitoring covered species and their habitats at the site level.
- Develop habitat models for agricultural areas and other potential pre-development situations.
- Develop Best Management Practices (BMPs) for created habitats.

Because the LCR MSCP is a habitat-based program, presence/absence of covered species is not a requirement for determining success. However, presence of targeted covered species will provide information to better provide habitat requirements for these species.

During this first 5-year period, the principal area of created fish habitat is the 80 acres of backwaters excavated on Imperial NWR. Use of these ponds to accomplish fish augmentation, species research, and created habitat research will take priority over their development and ultimate use as native fish refugia. Post-development monitoring activities will be incorporated into and combined with the monitoring and research being done to accomplish other program purposes.

Table 1. List of work tasks for FY08 that involve monitoring or research applicable to the 5-year priority plan.

C-2	Sticky Buckwheat and Threecorner Milkvetch Conservation
C-3	Multi-Species Conservation Program Covered Species Profile Development
C-4	Relict Leopard Frog
C-5	Effects of Abiotic Factors on Insect Populations in Riparian Restoration Sites
C-7	Survey and Habitat Characterization for MacNeill's Sootywing
C-8	Razorback Sucker Survival Studies
C-9	Razorback Sucker and Bonytail Pen Rearing Tests
C-10	Razorback Sucker Growth Studies
C-11	Bonytail Rearing Studies
C-12	Demographics and Post Stocking Survival of Repatriated Razorback Suckers in Lake Mohave
C-13	Lake Mead Razorback Sucker Study
C-14	Humpback Chub Program Support
C-15	Flannelmouth Sucker Habitat Use, Preference and Recruitment Downstream of Davis Dam
C-23	Evaluation of Remote Sensing Techniques for PIT Tagged Fish

C-24 Avian Species Habitat Requirements
C-25 Imperial Ponds Native Fish Research
D-1 Marsh Bird Surveys
D-2 Southwestern Willow Flycatcher Presence/Absence Surveys
D-3 Southwestern Willow Flycatcher Habitat Monitoring
D-4 Southwestern Willow Flycatcher Presence/Absence Survey Hualapai Tribe
D-5 Monitoring Avian Productivity and Survivorship
D-6 System Monitoring for Riparian Obligate Avian Species
D-7 Yellow-Billed Cuckoo Presence/Absence Surveys
D-8 Razorback Sucker and Bonytail Stock Assessment
D-9 System Monitoring and Research of Covered Bat Species
D-10 System Monitoring and Studies on Small Mammal Populations
E-1 Beal Lake Riparian and Marsh
E-2 Beal Lake Native Fish
E-3 'Ahakhav Tribal Preserve
E-4 Palo Verde Ecological Reserve
E-5 Cibola Valley Conservation Area
E-6 Cottonwood Genetics Study
E-7 Mass Transplanting Demonstration
E-8 Seed Feasibility Study
E-14 Imperial Ponds
E-15 Backwater Site Selection
E-16 Conservation Area Site Selection
F-1 Habitat Monitoring
F-2 Avian Use of Restoration Sites
F-3 Small Mammal Colonization of Restoration Sites
F-4 Post-Development Monitoring of Covered Bat Species
F-5 Post-Development Monitoring of Fish Restoration Sites
G-3 Adaptive Management Research Projects
G-4 Science/Adaptive Management Strategy

LITERATURE CITED

- Allison, L.J., C.E. Paradzick, J.W. Rourke, and T.D. McCarthy. 2003. A characterization of vegetation in nesting and non-nesting plots for southwestern willow flycatchers in central Arizona. *Studies in Avian Biology* 26:81-90.
- Andersen, D.C., and M. Nelson. 1999. Rodent use of anthropogenic and 'natural' desert riparian habitat, lower Colorado River, Arizona. *Regulated Rivers: Research & Management* 15:377-393.
- Arizona Game and Fish Department. 2001. *Rana yavapaiensis*. Unpublished abstract compiled and edited by the Heritage Data, Management System, Arizona Game and Fish Department, Phoenix, AZ. 6 pp.
- Brennan, T.C., and A.T. Holycross. 2006. Amphibians and Reptiles in Arizona. Arizona: Arizona Game and Fish Department.
- Brown, M., and J.J. Dinsmore. 1986. Implications of marsh size and isolation for marsh bird management. *Journal of Wildlife Management* 50:392-397.
- Brown, P. 2006. Lower Colorado River bat monitoring protocol. Draft report submitted to the U.S. Bureau of Reclamation. 30 pp.
- Cameron, G.N., and S.R. Spencer. 1981. *Sigmodon hispidus*. Mammalian species. No. 158. American Society of Mammalogists. 1-9 pp.
- Carothers, S.W. 1974. Breeding ecology and time-energy budget of male vermilion flycatchers and comments on the social organization of southwestern riparian birds. Ph.D. dissertation, University of Illinois, Chicago.
- Conway, C.J. 1990. Seasonal changes in movements and habitat use by three sympatric species of rails. M.S. thesis, University of Wyoming, Laramie.
- Conway, C.J., W.R. Eddlemen, S.H. Anderson, and L.R. Hanebury. 1993. Seasonal changes in Yuma Clapper Rail vocalization rate and habitat use. *Journal of Wildlife Management* 56:282-290.
- Conway, C.J., C. Sulzman, and B. Raulston. 2002. Population trends, distribution, and monitoring protocols for the California black rail. Technical report (Heritage Program IIPAM Grant # 199010). Arizona Game and Fish Department, Phoenix, Arizona.
- Corman, T.E. 2005. Summer Tanager. *In* The Arizona Breeding Bird Atlas. (Corman, T. E. and Wise-Gervais, eds.) University of New Mexico Press, Albuquerque.

- Eddleman, W.R. 1989. Biology of the Yuma Clapper Rail in the southwestern U.S. and northwestern Mexico. Final Report, U.S. Bureau of Reclamation, Yuma Project Office, Yuma, AZ. 127 pp.
- Eddleman, W.R., and C.J. Conway. 1998. Clapper Rail (*Rallus longirostris yumanensis*). In The Birds of North America, No. 340 (A. Poole and F. Gill eds.) The Birds of North America, Inc., Philadelphia, PA.
- Flores, R.E., and W.R. Eddleman. 1991. Ecology of the California black rail in southwestern Arizona. Final Report, U.S. Bureau of Reclamation, Yuma Project Office and Arizona Department of Game and Fish, Yuma, AZ.
- Gibbs, J.P., and S.M. Melvin. 1992. Least Bittern. In Migratory Nongame Birds of Management Concern in the Northeastern United States (K. Schneider and D. Pence, Eds.). U.S. Fish & Wildlife Service, Newton Corner, MA.
- Gibbs, J. P., F. A. Reid, and S. M. Melvin. 1992. Least Bittern. In The Birds of North America, No.17 (A. Poole, P. Stettenheim, and F. Gill, Eds.). Philadelphia: The Academy of Natural Sciences, Washington, DC: The American Ornithologist's Union.
- Great Basin Bird Observatory. 2003. Nevada Bird Count: A habitat-based monitoring program for breeding birds of Nevada. Great Basin Bird Observatory, Reno, NV. 19 pp.
- Halterman, M. 2001. Population status of the yellow-billed cuckoo at the Bill Williams River NWR and Alamo Dam, Arizona and southern Nevada: Summer 2000. Prepared for the U.S. Bureau of Reclamation, Lower Colorado Regional Office, Boulder City, NV.
- Halterman, M.D., S.A. Laymon, and M.J. Whitfield. 1987. Population assessment of the elf owl in California. Final Report to Nongame and Mammal Section, Wildlife Management Division, California Department of Fish and Game.
- Hensley, M.M. 1954. Ecological relations on the breeding bird population of the desert biome in Arizona. Ecological Monographs 24:185-207.
- Johnson, M.J., Holmes, J.A, and Weber, R. 2005. Yellow-billed cuckoo distribution and abundance, habitat use, and breeding ecology along the lower Colorado River (Yuma, AZ-United States/Mexico Border), Cibola NWR, Imperial NWR, Picacho State Recreation Area, CA, Mittry Lake WMA, Colorado/Gila River Confluence, Gila River and Quigley Pond WMA, 2005. Northern Arizona University.
- Koronkiewicz, T.J., M.A. McLeod, B.T. Brown, and S.W. Carothers. 2006. Southwestern willow flycatcher surveys, demography, and ecology along the lower Colorado River and tributaries, 2005. Annual report submitted to the U.S. Bureau of Reclamation, Boulder City, NV, by SWCA Environmental Consultants, Flagstaff, AZ. 176 pp.

- Laymon, S.A., and M.D. Halterman. 1989. A proposed habitat management plan for yellow-billed Cuckoos in California. USDA Forest Service General Technical Report PSW-110 pp. 272-277.
- Laymon, S.A., P.L. Williams, and M.D. Halterman. 1997. Breeding status of the yellow-billed cuckoo in the South Fork of the Kern River Valley, Kern County, Ca: Summary Report 1985-1996. Prepared for USDA Forest Service, Sequoia National Forest, Cannell Meadow Ranger District. Challenge Cost-share Grant #92-5-13.
- Ligon, J.D. 1968. The biology of the elf owl, *Micrathene whitneyi*. University of Michigan Museum of Zoology. Miscellaneous Publication 136.
- Lower Colorado River Multi-Species Conservation Program. 2004a. Lower Colorado River Multi-Species Conservation Program, Volume II: Habitat Conservation Plan. Final. 385 pp.
- Lower Colorado River Multi-Species Conservation Program. 2004b. Lower Colorado River Multi-Species Conservation Program Funding and Management Agreement. 39 pp.
- Lower Colorado River Multi-Species Conservation Program. 2006a. Draft Final Science Strategy. U.S. Bureau of Reclamation, Lower Colorado Region, Boulder City, NV. 66 pp.
- Lower Colorado River Multi-Species Conservation Program. 2006b. Final Fish Augmentation Plan. U.S. Bureau of Reclamation, Lower Colorado Region, Boulder City, NV. 15 pp.
- Lower Colorado River Multi-Species Conservation Program. 2007a. Species Accounts for the Lower Colorado River Multi-Species Conservation Program. U.S. Bureau of Reclamation, Lower Colorado Region, Boulder City, NV. 348 pp.
- Lower Colorado River Multi-Species Conservation Program. 2007b. Final Implementation Report, Fiscal Year 2008 Work Plan and Budget, and Fiscal Year 2006 Accomplishment Report. U.S. Bureau of Reclamation, Boulder City, NV. In Production.
- McCabe, R.A. 1991. The Little Green Bird, Ecology of the Willow Flycatcher. Madison, WI. 171 pp.
- McKernan, R.L., and G. Braden. 2001. Status, distribution, and habitat affinities of the southwestern willow flycatcher along the lower Colorado River, Year 4 – 1999. Report submitted to U.S. Bureau of Reclamation, U.S. Fish & Wildlife Service, and U.S. Bureau of Land Management. San Bernardino County Museum, Redlands, CA. 83 pp.
- McKernan, R.L., and G. Braden. 2002. Status, distribution, and habitat affinities of the southwestern willow flycatcher along the lower Colorado River, Year 6 – 2001. Report submitted to U.S. Bureau of Reclamation, U.S. Fish & Wildlife Service, and U.S. Bureau of Land Management. San Bernardino County Museum, Redlands, CA. 58 pp. plus Appendix.

- NatureServe. 2006. NatureServe Explorer: An online encyclopedia of life [web application]. Version 5.0 NatureServe, Arlington, Virginia. <http://www.natureserve.org/explorer>
- Paradzick, C.E. 2005. Southwestern willow flycatcher habitat selection along the Gila and Lower San Pedro Rivers, Arizona: Vegetation and hydrogeomorphic considerations. M.S. thesis, Arizona State University, AZ. 148 pp.
- Robinson, W.D. 1996. Summer Tanager (*Piranga rubra*). In The Birds of North America (A. Poole and F. Gill, eds.), No. 248. Birds of North America, Philadelphia.
- Rosenberg, K.V., R.D. Ohmart, W.C. Hunter, and B.W. Anderson. 1991. Birds of the Lower Colorado River Valley. University of Arizona Press, Tucson.
- Sedgwick, J.A., and F.L. Knopf. 1992. Describing willow flycatcher habitats: Scale perspectives and gender differences. Condor 94:720-733.
- Serena, M. 1986. Distribution, habitat preferences, and reproductive success of Arizona Bell's vireo (*Vireo bellii arizonae*) along the lower Colorado River in 1981. Final Report, California Department of Fish and Game, Sacramento.
- Sogge, M.K., and R.M. Marshall. 2000. A survey of current breeding habitats. Chapter 9 In Status, Ecology, and Conservation of the Southwestern Willow Flycatcher (D. Finch and S. Stoleson, eds.). USDA Forest Service, Rocky Mountain Research Station, Albuquerque.
- Stebbins. 1985. A Field Guide to Western Amphibians and Reptiles 2nd ed. Houghton Mifflin Co., Boston, MA. 336 pp.
- Stoleson, S.H., and D.M. Finch. 2003. Microhabitat use by breeding southwestern willow flycatchers on the Gila River, New Mexico. Studies in Avian Biology 26:91-95.
- Unitt, P. 2006. Summer tanager (*Piranga rubra cooperi*). Habitat Conservation Planning Branch, California Department of Fish and Game, Sacramento.
- U.S. Fish and Wildlife Service. 2002. Southwestern Willow Flycatcher Recovery Plan. Albuquerque, NM. i-ix plus 210 pp., Appendices A-O.
- Weller, M.W. 1961. Breeding biology of the least bittern. Wilson Bulletin 73:11-35.
- Weller, M.W., and C.S. Spatcher. 1965. Role of habitat in the distribution and abundance of marsh birds. Agricultural and Home Experiment Station Special Report 43, Iowa State University, Ames.
- Williams, J.A. 2001. Community structure and habitat use by bats in the upper Moapa Valley, Clark County, Nevada. Unpublished M.A. thesis, University of Nevada Las Vegas. 55 pp.

Wise-Gervais, C. 2005. Yellow warbler *Dendroica petechia*. In The Arizona Breeding Bird Atlas (Corman, T. E. and Wise-Gervais, eds.). University of New Mexico Press, Albuquerque, NM.